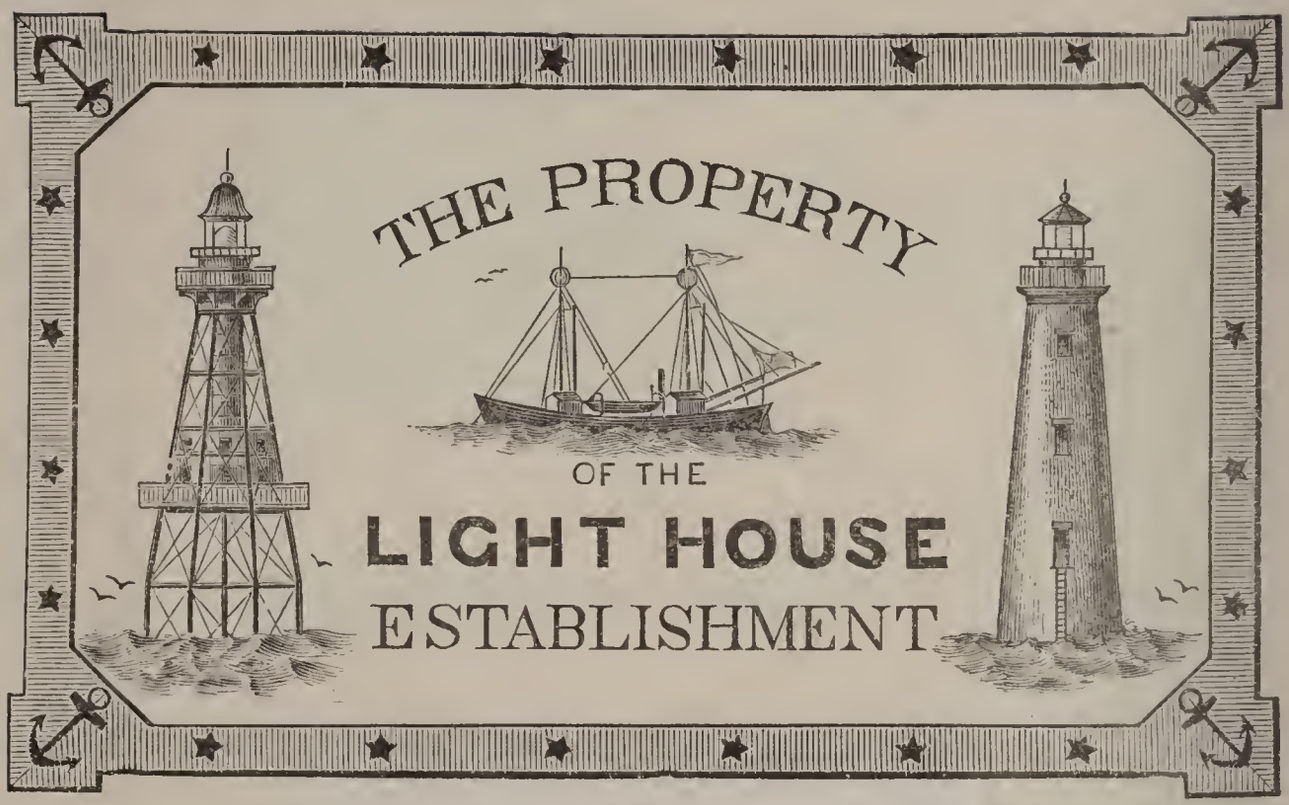

REPORT

OF AN

EXAMINATION

OF THE

OHIO DIAMOND COAL CO. PROPERTIES

IN

JEFFERSON COUNTY, O.,

BY

PROFS. B. SILLIMAN, JR. AND J. A. PORTER,

OF YALE COLLEGE.

MAY, 1855.

NEW HAVEN:

T. J. STAFFORD, PRINTER.

1855.

REPORT.

To the Officers and Shareholders of the Ohio Diamond Coal Company.

GENTLEMEN :—

At the request of some of the largest proprietors in your Company, we have lately visited and examined the Coal and Iron lands, Coal openings, and other properties, belonging to your Company. There are two distinct estates, distant some four miles from each other, both in Jefferson county, Ohio, and both on the Ohio river. The upper property is situated at the point of junction, where the Big Yellow Creek meets the Ohio; the lower estate is about four miles below this point, also on the Ohio.

A glance at the map of the United States will show that at this point the Ohio river makes a far-reaching north westerly sweep, and carries its waters within rather less than one hundred miles of Lake Erie at Cleveland. By this physical conformation not only are the interests of social and commercial intercourse greatly promoted between the shores of all the great lakes and the valley of the Mississippi, but the most valuable part of the great Western extension of the Appallachian Coal Field is laid open to navigable waters and lines of railway communication. By this natural and most direct channel of intercourse, following the valley of the Yellow Creek to its mouth, and the Ohio above and below, the Cleveland and

Pittsburg Railway has been constructed, connecting Lake Erie on the one hand with Pittsburg and the East, and on the other with Wheeling and Cincinnati.

These great and permanent natural advantages of position would of themselves ensure at no distant day a prosperons commercial and manufacturing town at or near one of the two points now held by your Company. But when to these advantages of geographical and commercial position are added the great and controlling elements of Coal and Iron in boundless quantity and of excellent quality, it is easy to see that the Ohio Diamond Coal Company, in holding the select points both of real estate and mineral value and river frontage, is sure to meet by the regular and progressive development of the country at large, and of its own resources in particular, any reasonable degree of wealth and prosperity which the most sanguine expectations of its stockholders may anticipate.

Such is the general geographical and commercial position of your estates in Jefferson county. Let us examine the upper property more particularly.

This property is situated on the left bank of the Yellow Creek and of the Ohio river, and corners near the mouth of the creek where a small stream called Block House run (famous in Logan's wars) enters the creek. The line of your property follows a N. W. course up this river at its eastern boundary, about two miles, until it meets a small cross valley, where, turning to the West, it follows the course of another small affluent of Yellow Creek, to its junction with the same, near the bridge of the Cleveland and Pittsburg Railway over this stream. Thence to the mouth of the Yellow Creek the right bank of that stream is the boundary of the property. The area contained within these limits embraces between 500 and 600 acres of land, being in fact a well formed symmetrical hill

or mountain covered with a dense growth of hard wood timber and rising to the estimated height of about 900 feet. Not one acre of this property is waste land to the Company; the whole of it is underlaid by workable beds of Coal. The flats, although narrow, are sufficient for a village, manufactories and landings, while the whole water front upon the creek (the bed of the stream belonging to the Company) is as admirably situated as can well be imagined for the delivery of coal by gravity from the openings of the beds to boats and barges on the water or to freight wagons upon the railway. The whole of this point is flanked by the railway track and the switches bring the freight wagons directly under the coal shutes at the pits' mouths.

The whole eastern boundary of the property on Block House run, is also as well situated as could be desired for coal openings, should it at any time be deemed desirable to connect that part of the property with the river frontage by a tram road. In this connection it is also proper to remark, that the projected line of railway destined to connect Ashtabula with the Ohio, passes down the valley of Block House run. Should this work at any future time be completed your Company will have a third outlet to their property, enabling them to deliver coal on Lake Erie some sixty miles east of Cleveland.

Thus by natural and artificial channels of commerce without cost to the Company, its property is brought into the best possible relation to two great markets, the Northern and the Southern, to the great lakes and Canada on the one hand, and the steam marine and commercial cities of the Ohio and Mississippi on the other. Is the Ohio at any time (and it is always so in summer) impassable for your barges, Cleveland, Buffalo, Toronto, Detroit and Chicago are open to your coal. Is Lake Erie frozen, or are its markets supplied, you have two

of the best landings on the Ohio river, where steamers can always take in coal, and your barges and steam tugs, safely moored in your own deep and quiet pool in Yellow Creek, are ready at a moment's notice to take the earliest swell of a freshet and glide down to Cincinnati, Louisville, and other Southern ports, with every advantage possessed by the most favorably situated openings on the Ohio or its tributaries, and with a gain of about two hundred miles in distance over the coal boats of the Alleghany and Monongahela, hitherto the chief sources of Southern supply.

We are informed that a responsible party stands ready to contract for the delivery of your coal at Cincinnati for fifty cents per tun, whenever the river is open to this navigation, furnishing himself with barges and steam power for this purpose. As the cost of freight by railroad to Cleveland can never be reckoned at less than three times this amount, (viz, $1.50 per tun,) it is plainly the interest of the Company to run its coal to the Southern markets whenever navigation will allow of its being done. Most fortunately for your interests, the seasons for these two markets are so arranged by unchangeable natural laws, that when the one is open the other is closed, and vice versa. Only those acquainted with the river trade can fully appreciate this advantage.

THE COAL AND ITS POSITION.

When we remember that not less than 150,000 square miles are embraced within the geological boundaries of the great Appallachian and other Coal fields of the United States, it is plain that the value of any particular portion of so wide an area must depend entirely upon its comparative advantages of position—geologically, geographically and commercially—and still more if possible upon the quality and abundance of its

workable beds of coal. Those who have turned their attention to the examination of the coal measures of the Ohio valley are fully aware how seldom it is that we can find more than one or two of the essential features of a good coal property embraced in any one portion. If the beds are regular, thick and well covered, they are either too remote from navigable waters or means of transportation, or the dip of the strata is such that artificial drainage is necessary. In other situations the cover is too thin or is so much cut down that no sufficient spread of sound coal can be found.

Again, as is true of the whole peninsula of Michigan and much of northern Indiana and Illinois, and some parts of Ohio, the coal measures are entirely beneath the line of natural drainage, or where they do come within reach, the coal is of inferior quality from want of sufficient cover, and the presence of much sulphuret of iron. In this connection we may remark that the price current of Chicago the last week of April quotes your coal at $8.50 per tun, while the coal of openings in Illinois within one hundred miles of Chicago, is quoted at $5.50.

The coal measures in your property are seven in number, as shown on the section and map prepared by Professor Forrest Shepherd, and appended to this report. This map, so far as we are able to decide from our somewhat hasty examination, is correct in its essential features, and the order of stratification is correctly represented. We did not measure all the minor beds of coal, nor all the intermediate shales, clays and sandstones, nor could this have been accomplished without making numerous fresh sections on the face of the hill, for which we had not time. But we did measure the chief and most important numbers of the series, and are happy to confirm the cautions and carefully considered statements of Professor Shepherd.

The dip of the whole system of beds in this hill is southeast at the angle of about 25 or 30 feet in a mile. This angle is quite enough for efficient drainage and for the easy descent of the coal by gravity, aided by animal power, to the shutes. How happy this circumstance of natural drainage is for the success of your enterprise, let those declare whose misfortune it is to work coal on the other side of the water shed.

The whole thickness of coal above water line in this mountain, (divided between the seven beds,) is nearly or quite 30 feet or ten yards. Of this, it is safe to reckon seven yards or twenty-one feet as workable.

The three beds most favorably situated for immediate use are 1st, The "Shepherd vein," rather less than three feet; 2nd, the "Ray vein," (next above it,) about four feet, (showing five feet in some places,) and 3d, the great "Diamond bed," over eight feet. The floor of the latter bed is about 80 feet above the Railroad. These three beds have been well proved and the coals are regularly sent to market. Some more particular notice of each of these may be expected, and especially of the great bed.

THE GREAT DIAMOND BED.

This we believe to be the same as the great ten foot bed of the Pittsburg region, and it is probably also the great bed of the Cumberland and other bituminous coal districts. Its floor on your property is a heavy bedded sandstone, 20 feet in thickness, forming the cover of roof of the "Ray vein," the next seam below. No under clay or stratum of soft and yielding material of any kind whatsoever, is found between this coal and its sandstone floor. The coal comes down with a sharp, well defined line upon this floor, which is as clean and smooth as a well dressed flagstone, and as far as galleries have been

driven upon it, nearly a mile in all a perfect uniformity of level and of character is preserved. The roof is a heavy bedded bituminous slate, four to six feet thick, sometimes so silicious and hard as to resemble a sandstone. It is not less uniform in its position than the floor, and appears so far to be equally permanent and unchanging. The advantage of this permanent floor and roof, as respects cheapness of mining, safety and cleanliness, can only be appreciated by those who have been familiar with the expense and inconveniences and dangers of those mines where a soft under clay allows the weight of the superincumbent strata to descend, crushing the pillars of coal and wood stantions left to support the roof, and soon effectually closing up the avenues of the mine. This "creeping," as it is technically called, will never be experienced in the Diamond bed. The system of work adopted by Captain Roberts, your intelligent mining director, is to take out the coal in chambers seven yards square, leaving columns of three yards square at equal distances. In one situation in the mine where the intersection of tram roads rendered it convenient to do so, one or more of these columns has been removed, and as a precaution timber has been set up in its place. But we observed that there was no pressure upon the timbers, which still yielded to the blows of the hammer, thus showing conclusively the strength of the roof and floor.

The coal in this great bed is divided at the height of about three feet from the floor, by a seam of pyritous shale less than one inch in thickness. Nothing could be more conveniently situated for the ease and rapidity of working. Upon this shale the collier bears in with his pick, thus making a well situated fissure, by which means the full force of his blast is felt in throwing down in large masses the upper division of the coal—the lower division serving him as a bench, for the convenient

removal of the upper until in its turn it is raised by gun powder from beneath, and the whole contents of the seam are made available with the least possible waste of coal. The great facility of mining offered by these uncommon advantages of position and structure will enable you to take out this bed at the minimum price of coal mining—a price very materially less than that which this Company has hitherto paid. Permit us here to suggest with reference to the future working of this great bed and its associates, the importance of an accurate topographical and mining survey of this whole property, with a view of determining with accuracy the best position for the great gallery of the mine, by the judicious placing of which the best drainage, ventilation and transportation of the whole material may be effected.

Such a gallery should be wide enough for two or three tram tracks, and should be a trunk or base line, to which all lateral galleries should drain. It is evident that the main axis of the hill should be the line of direction for such a gallery, as being at once the lowest point for drainage, and furnishing the shortest outlet for the contents of the labyrinth of chambers which in time must open upon it. Whether the present main entrance is placed in the best position, or whether it may not be best to have two or more such entrances converging to the axis of the hill, are open questions which can only be satisfactorily answered by such a survey as we suggest.

An additional advantage of such a survey would be, that in determining the contour line of the hill at the several levels of the successive beds of coal, where they outcrop, an accurate estimate will be reached of the amount of available coal in each bed, and the thickness of its cover, thus giving the data for a reliable opinion of the grand total of a fossil fuel, which lies in your property above water level. Until such a survey

has furnished the means of accurate statement, all calculations to this end must be regarded as only rough approximations. Whatever exact amount of coal such a survey may show to exist in your property, not the smallest doubt can be felt, from a cursory examination, that the gross available quantity is to be estimated at many millions of tons. Nor is there room for any other opinion than that the several seams enumerated are continuous in and under the whole property, and of the average thickness specified.

The character of the coal of the Diamond bed is very uniform: it is hard and compact, weathers well, and is firm even on its outcrop, where it is usual to find coal reduced to powder. It showed occasional spangles of sulphuret of iron, but not more, we should say, than is usual in the best coals of the bituminous regions. The seams or joints in this coal show also occasional coatings of calcareous spar or carbonate of lime. It bears transportation well, and yields a very small amount of "slack" at the shutes.

It burns with a clear, free blaze, makes a strong and sound coke of about one-third greater bulk than the original coal; its density, in its average state, is 1.314, making a cubic yard, or 27 cubic feet, of it weigh 2,216 pounds.

Its power of absorption of water is equal to 0.639 per cent., as determined by our own experiments.

It yields by coking 4.5 feet of gas to the pound of coal: this gas has a density of .5213,* and burns with moderate brilliancy, equal in a fish-tail burner consuming four cubic feet per hour, to 3.6 Judd's sperm candles, (sixes.) The measurements

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* This density is probably too high, owing to the presence of carbonic acid, derived from carbonate of lime, contained in the seams of the coal, and not perfectly separated by our means of purification.

of the comparative illuminating power of the several coals of your property have been made with a very accurate photometer.

Its composition is one hundred parts as follows:

Volatile matter expelled by coking (Of which .639 per cent. is water,)	43.04	per cent.
Carbon, ...	52.51	"
Ashes, ...	4.45	"
	100.00	per cent.
Coke yielded by this trial	56.96	

THE "RAY BED"

Is immediately under the "Diamond," being separated from it by the above named bed of firm sandstone, equal to about 20 feet in thickness. The roof of the Ray bed is, therefore, sandstone, and its floor is limestone, with a narrow strip of fire clay. This bed is usually spoken of as being *four* feet in thickness, but this is a very moderate statement, as we saw it in more than one place considerably exceeding this thickness.

This is an exceedingly beautiful coal to the eye, being richly painted with dark purple and violet tints, rendering it worthy of the name, "Peacock Coal," as it is sometimes called. This color does not appear to be due to a film of sulphuret of iron, as some have suggested; but is more probably attributed by Dr. Hayes, the distinguished chemist, of Boston, to a thin varnish of crenate of lime, a salt, resulting from the action of atmospheric waters upon the soil. It has been suggested by those whose opinion is entitled to consideration, that this is the best bed in the whole series for the manufacture of iron. We do not hazard an opinion on this point, since in our judgment actual trial alone is competent to decide a question to the solution of which so many delicate practical considerations

are affixed. In breaking large masses of this coal broad surfaces of "mineral charcoal" are visible, giving it, together with its brilliant peacock hues, a very well characterized appearance. In point of strength to resist transportation, the Diamond bed appears to us to be superior to this. We are of opinion that in the market this coal will be very favorably regarded by consumers, as well for its intrinsic qualities as for its very beautiful appearance.

CHEMICAL CHARACTER OF THE "RAY COAL."

Density 1.303, giving 2,198 lbs. as the weight of a cubic yard. Its power of absorption is equal to 0.75 per cent. By analysis it yields

Volatile matter including water . .	43.76	per cent.
Carbon	48.70	"
Ash	7.54	"
	100.00	per cent.
Coke in	~~76.54~~	"

56.2

The coke is equal to one and one-third bulks.

One pound of this coal yields four cubic feet of gas, having a density of .4928, and an illuminating power equal to nine of Judd's patent sixes.*

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* We would here state, that wishing to obtain, as nearly as possible, results which should correspond with the actual experience of the Gas House, we have employed in these trials of the illuminating value of the coals tested an experimental gas retort of iron, heated as in the usual gas oven, and holding one pound or more of each coal. The retort was in each case heated to the proper degree before introducing the weighed charge of raw coal.

The gases produced were purified and cooled as nearly as possible in a manner similar to the existing practice of gas houses, and the product was measured by passing through a dry gas meter, reading to one-tenth of a cubic foot. After passing this meter the gas was received in a holder, ready for further use. The density was determined in an exhausted globe of glass holding 133 grains

THE "SHEPHERD VEIN"

Rests about 50 feet below the last described bed. It is a very bright, handsome coal, and much esteemed as a gas coal. It is, perhaps, more friable than the Diamond bed, but is stronger than the "Ray." The bed is rather thin, and probably on this account it would be hardly advisable to work it for coal alone, although beds of three feet are not unfrequently worked with profit. But it happens that immediately over this coal is a good belt of kidney iron ore, while immediately under it lies the great bed of fire clay.

In the progress of development of the property it will be requisite to take out large quantities of both these materials, and especially of the iron ore, thus rendering the Shepherd vein as easy to work as its thicker associates.

CHEMICAL CHARACTER OF THE "SHEPHERD VEIN" COAL.

Density 1.309, giving 2,208 lbs. as the weight of a cubic yard. Its power of absorption is equal to 0.53 per cent. By analysis it yields

Volatile matter including water . .	40.53	per cent.
Carbon fixed	57.32	"
Ash	2.15	"
	100.00	per cent.
Coke	59.47	"

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of atmospheric air. These trials were made under average states of pressure and moisture, and with observation of the state of the barometer and thermometer.

The purifying arrangements employed did not prove sufficient to remove all the sulphuretted hydrogen and carbonic acid, and undoubtedly better gas can be made from the coals in the *large way* than we obtained, especially from the Diamond coal. The Shepherd vein, from the facility with which it cokes, and the large volume of rich gas it yields, is, in our opinion, the best gas coal we have any knowledge of, excepting the Hillsboro asphaltic coal.

The coke is equal to one and one-third bulks.

One pound of this coal yields five cubic feet of gas, having a density of 5.086, and an illuminating power equal to 8.4 Judd's patent sixes.

In order to furnish the means of comparison between the coals of the Ohio Diamond Coal Company and some other well known American and European coals, as respects chemical composition and illuminating power, we have made a calculation of the Newcastle bituminous, now in use by the New Haven City Gas Company, and of the celebrated Hillsboro (N. B.) asphaltic coal:

TABULAR STATEMENT

OF COALS OF OHIO DIAMOND COAL COMPANY, AS COMPARED WITH OTHERS.

Name of Coal.	Specif. Grav.	Weight of Cubic Yard.	Ash.	Coke.	Volatile Matter.	Water	Carbon.	Cubic feet of gas to 1 lb.	Specif. Grav. of gas.	Equal to of Judd's Sixes.
Diamond	1.314	2,216	4.45	56.96	43.04	0.639	52.51	4.5	52.12	3.6
Ray	1.303	2,198	7.54	56.24	43.76	0.75	48.70	4	49.28	9
Shepherd.....	1.309	2,208	2.15	59.47	40.63	0.53	57.32	5	50.86	8.4
Newcastle	1.277	2,154		69.59	30.41			3.8		5.4
Hillsboro	1.129	1,905	2.22	28.26	61.74		26.04	6		21.8

The gas from the Newcastle coal, as found in the pipes of the New Haven Gas Company at this date, equals 5.4 of the standard candles when burned in a four feet Scotch tip fish tail burner.

The lowest Coal indicated on the section is seen in the Railway cut near the lower bridge, and is completely above drainage. It appears to us to be about four feet in thickness; we saw it, however, only in its out crop and cannot speak of its quality. If Professor Shepherd's opinion is well founded that this bed is identical with the Pennsylvania Coal known in market as the "Briar Hill Coal," we would respectfully suggest that it is worth while proving the quality of this bed on your property, since should it turn out to be a coal of equal quality

with that named, it will be remembered that this coal bears in the western markets the highest price, being quoted at Chicago one dollar more per ton than any other coal.

We cannot doubt that when your coals have been more fully tested by consumers, that their price, already high, will be ranked with the most favorite specimens now known.

Of the three upper beds of coal upon your property, we cannot speak from personal examination, although the points of their occurrence were indicated to us.

From what has been said of the quality and abundance of the coals on your upper property it will be seen that regarded only as a coal property it must, from its remarkable advantages of situation, prove amply remunerative to the shareholders, if it is worked even with tolerable energy and skill.

But the property has other value besides its coal. The chief of these is, beyond doubt, its *Iron Ores;* although the fire clay, limestone, sandstone and timber, are also very valuable.

THE IRON ORES.

These all belong to the class of calcareous ores or Carbonate of Iron, with various proportions of carbonates of lime and magnesia, alumina, &c. Such are always the iron ores of the coal formations. There are four seams of iron ore upon your property, one below the lowest visible coal seams, one immediately over the Shepherd coal, one of very valuable calcareous ore not far below the "Ray vein," and above which occurs a stratum of fossiliferous limestone. The last bed of iron ore rests upon the uppermost coal seam save one.

Less development of these beds of iron ore have been made than of the coal seams.

Two of them which we have examined at several points are

abundantly stocked with nodular iron in masses from the size of a kidney to those which will weigh from 100 to 200 pounds.

ANALYSES OF IRON ORES.

BAND IRON ORE.

Carbonate of Iron,	88.05 p. c.	=42.51 p. c. of Metallic Iron.
Alumina, . . .	2.68	"
Carbonate of Lime,	2.66	"
Silicic Acid, . .	5.85	"
Water, ...	.76	"
	100.00 p. c.	

Sp. gr. 3.592.

BALL IRON ORE.

Carbonate of Iron.,	84.72 p. c.	=40.90 p. c. of Metallic Iron.
Alumina, . . .	6.12	"
Carbonate of Lime,	2.43	"
Silicic Acid, . . .	5.82	"
Water, ...	0.91	"
	100.00 p. c.	

Sp. gr. 3.460.

The band or stratum which yields the so called calcareous ore appears to us peculiarly valuable, since the ore, as far as we are able to judge, contains sufficient lime to flux itself.

Taken in connection with the coal, limestone and fire clay, these ores must be esteemed of great value.

We broke very many of the nodules with a view of determining the presence of other metals or of sulphur, but we did not find a trace of anything but iron.

It is not easy to assign any reason why iron cannot be made here as cheaply as anywhere in the United States. Here every

natural facility that can be named is focalized. An abundant supply of cheap agricultural products is at hand, and the price of all the necessaries of life is as low as can be found anywhere. Nor is there much reason to fear any considerable increase for many years in the various items of subsistence, since by the river and various railroads agricultural produce of every description can be delivered here as cheaply as at any point in the whole West. By way of the Cleveland and Pittsburg Railroad, the rich specular iron ores of Lake Superior can be laid down at your mines at very remunerative prices. These ores are now carried by the Sharon Iron Company from their mines at Marquette, to their furnaces in Pennsylvania to the great advantage of the proprietors.

Recent developments on the north shores of Lake Superior lead us to anticipate that an unlimited supply of rich specular iron may be expected from sources not before known, and immediately on navigable waters—thus ensuring to the furnaces on the Ohio, a steady supply of these ores at a minimum price. It is by a judicious use of these rich ores with the more fusible ores of the coal measures that the skillful iron Master is able to vary the product of his furnaces to meet the demands of commerce. With this resource at hand it is possible to manufacture spring and blister steel. It remains to be determined by actual trial, whether any unforeseen difficulty lies in the way of employing the raw coal of your mines in the high furnace with a hot blast.

Should this trial when made prove as successful as we have reason to believe it will be, who will undertake to limit the future developments of the iron trade in all its branches at this point? We will only add in this connection, what is plain on the least reflection, that the iron furnaces situated in the valley of the Ohio will have always in their favor the cost of freight

from the various Atlantic ports to the Ohio—which of itself is no inconsiderable margin for a profitable business.

In addition to what has already been said respecting the mineral and other advantages of your property, it should be borne in mind that it is situated in one of the earliest settled parts of Ohio, the water is soft sandstone water, there are several good dwelling houses and numerous other buildings on the farm, which is in excellent tilth and furnished with good orchards of select fruit. The passengers by steamer also meet the trains of the Cleveland and Pittsburg Railroad upon your property.

The health of this region is as good as any part of the United States—no intermittent fevers are known and there are no prevalent diseases of any sort; without this circumstance all the other advantages we have enumerated, would be of far less value than they are now believed to be.

It appears highly probably that under your whole property there exists a powerful bed of coal never yet explored, so far as we can learn, at any point on the Ohio. It is in evidence from the records of the various salt wells bored at numerous points on this part of the Ohio, (one of which exists on your property,) that at different depths, according to the nature of the surface, a bed of coal from 11 to 12 feet thick was passed through. It is not likely that this evidence, drawn from numerour independent sources, can be quite erroneous, and as on your property this bed is reported at the moderate depth of only 40 feet below the level of the river, it will be no great undertaking at some future day to test it by a shaft.

The existence of salt water at this point on the Ohio is a fact of some interest, as the experience of past years has shown the practicability of manufacturing salt upon your property. It is also a fact of some interest that jets of illuminating gas are

obtained at a certain depth in the perforation of the salt wells, a circumstance which perhaps may be availed of hereafter for the cheap illumination of dwellings and manufactories, as has been done at Fredonia, N. Y. and at other places.

LOWER PROPERTY.

The lower property belonging to the Company is situated about four miles below the mouth of Big Yellow Creek, and on the same side of the Ohio river as the upper property already described.

The Wheeling branch of the Cleveland railroad passes directly through it from end to end, and the only ground appropriate for the station house and switches of the railroad is within the territory of the Company. On the southern end of this lower territory is one of the oldest ferries on the Ohio river, and the landing for steamers at all stages of water is perfectly good. The fine level plain between the river and the coal hills is far above extreme high water in the Ohio, and this plain is from 1000 to 1500 feet in width. The amount of land embraced in this portion of the Company's property is about 350 acres.

The hills containing the beds of coal and iron ore are not quite so high as the hills at the upper property, but from a single barometrical measurement we estimated it at not less than 650 feet.

Much less has been done upon this property in developing its beds of coal and iron than has been done in the other case. The bed which, from its position and the character of the coal, we inferred to be the Diamond bed, was at the point where we saw it over five feet in thickness and of excellent quality.

The lower stratum of iron ore is also well developed, and we recognize also the position of some other coal beds, and were convinced of the regularity of the succession in the series

being the same here as in the upper property—iron nodules occur in it in the greatest abundance. We also found on the hill at an elevated position (where it was to be expected) the great belt of calcareous iron ore so much esteemed above, and in abundant quantity.

We spent some time in wandering over this property in company with Prof. Shepherd, and the result of observations was the conviction that the Company possess here a very valuable resource for the future, either from its development or sale to another Company.

Here undoubtedly is the place for a prosperous manufacturing town to spring up. There is ample space of level ground, excellent water, with abundant coal, iron, timber and building stone, while the river and railroad offer the choice of means of transport.

As a coal property we prefer the upper place, but for the site of a village and the growth of a great manufacturing town, the lower property appears to us to offer peculiar advantages.

It remains for the Company to consider whether they will retain it with a view to its future development by their own industry, or whether they will seek a purchaser for it.

It is proper to add more explicitly than we have before done, that the whole of the upper property is *now in good working order and capable with its present accommodations of turning out from* 150 *to* 200 *tons per day.* As early as last fall the various entries already driven measured very nearly a mile, all on the coal, and since that time very considerable progress has been made. There are two inclines of 480 feet each, and a new switch for convenient loading of the Shepherd coal was in progress on the 1st of May. It is asserted by the mining captain, that he can now, taking the openings as they exist,

work one hundred and fifty miners, provided that the coal can be taken away from the openings.

In conclusion we would express the high satisfaction we have experienced as the result of our examination of your truly valuable property—too valuable not to receive the best and most efficient development you can give it.

Yours very respectfully,

B. SILLIMAN, Jr.,

Professor of General and Applied Chemistry in Yale College.

JOHN A. PORTER,

Professor of Agricultural and Analytical Chemistry in Yale College.

New Haven, May 15th, 1855.


MAP
OF
DIAMOND COAL MINES
IN
JEFFERSON COUNTY
OHIO.
Martin
Coal Bed 5 feet excellent quality
Sand Stone very good for Building.
Good Lime Stone
Iron Ore
Coal 20 ins. Good
Slate
Coal 4½ feet
Slate Lime Stone
Sand Stone
Great Coal Bed 8 Feet
Sand Stone
Coal 4 feet very good
Lime Stone
Very Rich Ore
White Clay
Sand Stone
Slate
Iron Ore
C.&P.R.R.
Coal 31 inches
Great Bed of Fire Clay
Good Coal 3. to 5 ft.
Iron Ore
Level of Yellow Creek & Ohio River
Coal Pits
Blacksmith Shop
Office
Coal Pit
Dram
Coal Pits
Coal Pits
Salt Well
CLEVELAND & PITTSBURG R.R.
CLEVELAND & PITTSBURG R.R.
BIG YELLOW CREEK
OHIO RIVER
Wm. Mc Cullough's
LITH. OF ENDICOTT & CO. N.Y.

REPORT

ON THE

ROCK OIL, OR PETROLEUM,

FROM

VENANGO CO., PENNSYLVANIA,

WITH SPECIAL REFERENCE TO ITS USE FOR ILLUMINATION AND OTHER PURPOSES.

BY B. SILLIMAN, JR.,

PROF. OF GENERAL AND APPLIED CHEMISTRY, YALE COLLEGE.

NEW HAVEN:

FROM J. H. BENHAM'S STEAM POWER PRESS.

1855.

The Supply of Oil.

We cannot rely on the ocean for a supply of oil at all adequate to the demands for actual use, for, notwithstanding the number of our whalers has been constantly increasing, the supply of whale oil has gradually fallen from 207,348 barrels in 1841 to 184,015 in 1856, and prices have been enhanced in proportion to the growing scarcity. The falling off in sperm oil is from 159,303 in 1841 to 72,649 in 1855. Even had there been no falling off in the quantity of oil procured from the whale, the increased demand for the requirements of railways, factories, &c., would exceed the means of supply. It has been estimated that a yearly consumption of 100,000 gallons of oil takes place on every 500 miles of the 25,000 miles of railway in operation in the United States. Various expedients have been resorted to for the supply of the deficiency, and oil has been manufactured from rosin, cotton seed, and other substances, with success. Our pine forests may no doubt be made to produce oil in large quantities. Not less than eight factories have been put in operation in this country within a short time, for the manufacture of oil from rosin, and another in Liverpool, Eng., on the same principle, which made, together, over 100,000 barrels of oil last year.

Until a recent period, the extraction of oils from coal has received but little attention, but now it is a well ascertained fact that all the rich bituminous coals are capable of yielding, by distillation at a high temperature, large quantities of oil having many points of resemblance with naptha, which is the usual product of distilling petroleum. Several large establishments have commenced in the United States for the manufacture of this new product, and though some of them are already in operation, with promises of abundant success, it is not probable that the valuable properties of coal oil have yet reached their highest development. The enormous and rapidly increasing consumption of oil by locomotives and other machinery, greatly enhancing its cost, exerts a powerful influence in the prosecution of chemical investigation in this direction.

At Cloveport, Ky., on the Ohio river, are extensive new works, running twelve retorts night and day, containing from eight to ten tons of coal every twenty-four hours, and producing 750 gallons of crude oil. Re-distilled, this quantity yields 600 gallons of refined oils, viz: 125 gallons of benzole, 75 of naptha, 255 of lubricating oil; and 175 of oil for illuminating purposes. Benzole readily sells at $1 50 per gallon; lubricating at $1 25; naptha and burning at 80 cents. Preparations are making at Cloveport for the manufacture of a beautiful semi-transparent candle from the substance called "parafine," resembling fine spermaceti, and which is formed in pearly crystals in the dark oils of the last distillations, after they have cooled. The parafine, as remarked by Prof. Silliman, Jr., does not exist ready formed in the original crude product, but is a result of the high temperature employed in the process of distillation, by which the elements are newly arranged. It derives its name from the unalterable nature of the substance, under the most powerful chemical agents. The candles made from it are considered superior to sperm. The Cloveport Co. use the Breckinridge cannel, and it is said to produce an illuminating oil equal to the best spermaceti, at a cost of about thirty cents per gallon—that of the coal being say six dollars per ton. In noticing these facts the Louisville Journal recently said—"If we have the best material for lighting the world—to say nothing of lubricating its wheels—we have something better than has yet been discovered in California." The residuum from the last distillation makes the first quality of asphaltum, used for smearing vaults, &c., now imported, and sold at thirty dollars per ton.

The company above mentioned will add eighteen more retorts on the first of November next, increasing the capacity of the works about two-thirds. Kerosene (or coal) oil works have been recently started on Newtown creek, L. I., where a large sum has been expended in their erection. They use American bituminous coals, which cost $12 or $15 per ton. So unexpectedly great has been the demand for the oil that the company has already commenced enlarging its works. At Darlington, Pa., there is a large establishment, which has been in operation six months, and with such success that a lease has been taken of the coal mines at that place. At Willinmsburg, near this city, a man, named Mahoney, has been manufacturing coal oil for some time past, making five barrels per week of superior benzole.

These, so far as we can ascertain, embrace all the manufactories now in this country; but they have multiplied very rapidly, considering the little attention which the subject has received. Benzole was first made from coal tar, but recent inventions have greatly facilitated its use, by improving its quality as well as by lessening its cost. Another circumstance in its favor is, that the dust or "slack" from rich veins may be converted into coke, and the volatile matter into benzole, oil, &c., at a remunerating profit; and if a portion of the volatile matter is allowed to remain in the coke, the latter forms an excellent article of fuel, without dust or smoke.—*Jour. of Com.*

REPORT.

Messrs. Eveleth, Bissell & Reed,

GENTLEMEN,—

I HEREWITH offer you the results of my somewhat extended researches upon the Rock Oil, or Petroleum, from Venango County, Pennsylvania, which you have requested me to examine with reference to its value for economical purposes.

Numerous localities, well known in different parts of the world, furnish an oily fluid exuding from the surface of the earth, sometimes alone in "tar springs," as they are called in the western U. S.; frequently it is found floating upon the surface of water in a thin flim, with rainbow colors, or in dark globules, that may, by mechanical means, be separated from the fluid on which it swims.

In some places wells are sunk for the purpose of accumulating the product in a situation convenient for collection by pumping the water out. The oil exudes on the shores of Lakes and Lagoons, or rises from springs beneath the bed of Rivers. Such are the springs of Baku, in Persia, and the wells of Amiano, in the duchy of Parma, in Italy. The usual geological position of the rocks furnishing this natural product, is in the coal measures—but it is by no means confined

to this group of rocks, since it has been found in deposits much more recent, and also in those that are older—but in whatever deposits it may occur, it is uniformly regarded as a product of vegetable decomposition. Whether this decomposition has been effected by fermentation only, or by the aid of an elevated temperature, and distilled by heated vapor, is perhaps hardly settled.

It is interesting, however, in this connection to remember, that the distillation, at an elevated temperature, of certain black bituminous shales in England and France, has furnished large quantities of an oil having many points of resemblance with Naphtha, the name given to this colorless oil, which is the usual product of distilling Petroleum. The very high boiling point of most of the products of the distillation of the Rock Oil from Venango County, Pa., would seem to indicate that it was a pyrogenic (fire produced) product.

Bitumen, Asphaltum, Mineral Pitch, Chapapote, &c., &c., are names variously given to the more or less hard, black resinous substance which is produced usually from the exposure of Petroleum to the air, and is found either with or without the fluid Naphtha or Petroleum. The most remarkable examples of the occurrence of these substances so intimately connected with the history of Rock Oil, are the Lake Asphaltites or the Dead Sea, so memorable in history, the well known Bitumen Lake of Trinidad, and the deposits of mineral pitch or Chapapote in Cuba. In one of the provinces of India, vast quantities of Petroleum are annually produced, the chief consumption being local, for fuel and lights, but a portion is also exported to Europe for the production of Naphtha. In the United States, many points on the Ohio

and its tributaries, are noted as producing this oil; nearly all of them within the coal measures. A detailed history of these various localities can be found recorded in books of science, and their repetition here would be out of place.

General Characters of the Crude Product.

The Crude oil, as is gathered on your lands, has a dark brown color, which, by reflected light, is greenish or bluish. It is thick even in warm weather—about as thick as thin molasses. In very cold weather it is somewhat more stiff, but can always be poured from a bottle even at 15° below zero. Its odor is strong and peculiar, and recalls to those who are familiar with it, the smell of Bitumen and Naphtha. Exposed for a long time to the air, it does not thicken or form a skin on its surface, and, in no sense, can it be called a drying oil. The density of the Crude oil is 882, water being 1000. It boils only at a very high temperature, and yet it begins to give off a vapor at a temperature not greatly above that of boiling water. It takes fire with some difficulty, and burns with an abundant smoky flame. It stains paper with the appearance of ordinary fat oils, and feels smooth and greasy between the fingers. It is frequently used in its crude state to lubricate coarse machinery. In chemical characters, it is entirely unlike the fat oils. Most of these characters are common to Petroleum from various places. In one important respect, however, the product of your lands differ from that obtained in other situations, that is, it does not, by continued exposure to the air, become hard and resinous like mineral pitch or bitumen. I have been informed by those who have visited the locality, that on the surface of the earth about the springs which furnish your oil,

there is no crust or deposit of this sort such as I have seen in other situations where Petroleum or mineral tar is flowing. This difference will be seen to be of considerable importance, as it is understood and represented that this product exists in great abundance upon your property, that it can be gathered wherever a well is sunk in the soil, over a great number of acres, and that it is unfailing in its yield from year to year. The question naturally arises, of what value is it in the arts, and for what uses can it be employed? To enable you to answer these inquiries has been the object of my researches.

Examination of the Oil.

To determine what products might be obtained in the oil, a portion of it was submitted to fractional distillation.* The temperature of the fluid was constantly regulated by a thermometer, the heat being applied first by a water bath, and then by a bath of linseed oil. This experiment was founded upon the belief that the crude product contained several distinct oils, having different boiling points. The quantity of material used in this experiment, was 304 grammes. The thermometer indicated the degrees of the Centigrade scale, but, for convenience, the corresponding degrees of Fahrenheit's scale are added. The water bath failed to distil any portion of the oil at 100°C. (=212° Fah.) only a small quantity of acid water came over. An oil bath, (linseed oil,) was then substituted, and the temperature was regularly raised by slow degrees until distillation commenced. From that point the heat was successively raised by stages of ten de-

* Fractional distillation is a process intended to separate various produets in mixture, and having unlike boiling points, by keeping the mixture contained in an alembic at regulated successive stages of temperature as long as there is any distillate at a given point, and then raising the heat to another degree, &c.

grees, allowing full time at each stage for complete distillation of all that would rise at that temperature before advancing to the next stage. The results of this tedious process are given in the annexed table—304 Grammes of Crude oil, submitted to fractional distillation, gave :

	Temperature.	Quantity.
1st Product at	100°C.=212°Fah. (acid water,)	5 Gms.
2d "	" 140°C. to 150°C.=284° to 302°Fah.	26 "
3d "	" 150°C. to 160°C.=302° to 320°Fah.	29 "
4th "	" 160°C. to 170°C.=320° to 338°Fah.	38 "
5th "	" 170°C. to 180°C.=338° to 356°Fah.	17 "
6th "	" 180°C. to 200°C.=356° to 392°Fah.	16 "
7th "	" 200°C. to 220°C.=392° to 428°Fah.	17 "
8th "	" 220°C. to 270°C.=428° to 518°Fah.	12 "
Whole quantity distilled by this method, . .		160
Leaving residue in the retort, . . .		144
Original quantity, ...		304

Product No. 1, as above remarked, was almost entirely water, with a few drops of colorless oil, having an odor similar to the original fluid, but less intense.

Product No. 2 was an oil perfectly colorless, very thin and limpid, and having an exceedingly persistent odor, similar to the crude oil, but less intense.

Product No. 3 was tinged slightly yellow, perfectly transparent, and apparently as limpid as the 2d product, with the same odor.

Product No. 4 was more decidedly yellowish than the last, but was in no other respect distinguishable from it.

Product No. 5 was more highly colored, thicker in consistence, and had a decided empyreumatic odor.

Product No. 6. This and the two subsequent products were each more highly colored and denser than the preced-

ing. The last product had the color and consistency of honey, and the odor was less penetrating than that of the preceding oils. The mass of crude product remaining in the retort, (equal 47.4 per cent.,) was a dark, thick, resinous looking varnish, which was so stiff, when cold, that it could be inverted without spilling. This showed no disposition to harden or skin over by exposure to the air. The distillation was arrested at this point in glass, by our having reached the limit of temperature for a bath of linseed oil. The *density* of the several products of this distillation, shows a progressive increase, thus :

No. 2,	density,	.733
No. 3,	"	.752
No. 4,	"	.766
No. 5,	"	.776
No. 6,	"	.800
No. 7,	"	.848
No. 8,	"	.854

To form an idea of the comparative density of these several products, it may be well to state, that Sulphuric Ether, which is one of the lightest fluids known, has a density of .736, and Alcohol, when absolutely pure, .815.

The *boiling points* of these several fluids present some anomalies, but are usually progressive, thus, No. 2 gave signs of boiling at 115° C. (=239 Fah.) and boiled vigorously, and remained constant at 225° C. to 228° C., (=437° to 442° Fah.) No. 3 began to boil 120°, (=248° Fah.,) rose to 270° (=518° Fah.,)where it remained constant. No. 4 began to vaporise at 140°, (=284° Fah.,) rose to 290°, (=554° Fah.,) where it remained constant. On a second heating the temperature continued to rise, and passed 305°, (=581 Fah.)

No. 5 gave appearance of boiling at 160°, (=320° Fah., boiling more vigorously as the heat was raised, and was still rising at 308°, (=581° Fah.) No. 6 commenced boiling at 135°, (=275° Fah.,) boiled violently at 160°, (=320° Fah.,) and continued rising above the range of the mercurial thermometer. No. 7 commenced ebullition at the same temperature as No. 6, and rose to 305°, (=581° Fah.,) where the ebullition was not very active. Much time was consumed in obtaining these results. We infer from them that the Rock Oil is a mixture of numerous compounds, all having essentially the same chemical constitution, but differing in density and boiling points, and capable of separation from each other, by a well-regulated heat.

The uncertainty of the boiling points indicates that the products obtained at the temperatures named above, were still mixtures of others, and the question forces itself upon us, whether these several oils are to be regarded as *educts*, (*i. e.*, bodies previously existing, and simply separated in the process of distillation,) or whether they are not rather produced by the heat and chemical change in the process of distillation. The continued application of an elevated temperature alone is sufficient to effect changes in the constitution of many organic products, evolving new bodies not before existing in the original substance.

Properties of the distilled Oils.

Exposed to the severest cold of the past winter, all the oils obtained in this distillation remained fluid. Only the last two or three appeared at all stiffened by a cold of 15° below zero, while the first three or four products of distillation retained a perfect degree of fluidity. Exposed to air,

as I have said, they suffer no change. The chemical examination of these oils showed that they were all composed of Carbon and Hydrogen, and probably have these elements in the same numerical relation. When first distilled, they all had an acid reaction, due to the presence of a small quantity of free sulphuric acid, derived from the Crude oil. This was entirely removed by a weak alkaline water, and even by boiling on pure water. Clean copper remained untarnished in the oil which had been thus prepared, showing its fitness for lubrication, so far as absence of corrosive quality is concerned. The oils contain no oxygen, as is clearly shown by the fact that clean potassium remains bright in them. Strong *Sulphuric Acid* decomposes and destroys the oil entirely. *Nitric Acid* changes it to a yellow, oily fluid, similar to the changes produced by Nitric Acid on other oils. *Hydrochloric*, *Chromic*, and *Acetic Acids*, do not affect it. *Litharge* and other metallic oxyds do not change it, or convert it in any degree to a drying oil. *Potassium* remains in it unaffected, even at a high temperature. *Hydrates of Potash*, *Soda*, and *Lime*, are also without action upon it. *Chlorid of Calcium* and many other salts manifest an equal indifference to it. Distilled with *Bleaching Powders* (chlorid of lime) and water, in the manner of producing chloroform, the oil is changed into a product having an odor and taste resembling chloroform. Exposed for many days in an open vessel, at a regulated heat below 212°, the oil gradually rises in vapor, as may be seen by its staining the paper used to cover the vessel from dust, and also by its sensible diminution. Six or eight fluid ounces, exposed in this manner in a metallic vessel for six weeks or more, the heat never exceeding 200°, gradually and slowly diminished, grew yel-

low, and finally left a small residue of dark brown lustrous looking resin, or pitchy substance, which in the cold was hard and brittle. The samples of oil employed were very nearly colorless. This is remarkable when we remember that the temperature of the distillation was above 500° Fah. The oil is nearly insoluble in pure alcohol, not more than 4 or 5 per centum being dissolved by this agent. In Ether the oil dissolves completely, and on gentle heating is left unchanged by the evaporization of the Ether. India Rubber is dissolved by the distilled oil to a pasty mass, forming a thick black fluid which, after a short time, deposits the india rubber. It dissolved a little Amber, but only sufficient to color the oil red. It also dissolves a small portion of Copal in its natural state ; but after roasting, the Copal dissolves in it as it does in other oils.

Use for Gas making.

The Crude Oil was tried as a means of illumination. For this purpose a weighed quantity was decomposed, by passing it through a wrought iron retort filled with carbon, and ignited to full redness. The products of this decomposition were received in a suitable apparatus. It produced nearly pure carburetted Hydrogen Gas, the most highly illuminating of all the carbon gases. In fact, the oil may be regarded as chemically identical with illuminating gas in a liquid form. The gas produced equalled ten cubic feet to the pound of oil. It burned with an intense flame, smoking in the ordinary gas jet, but furnishing the most perfect flame with the argand burner.

These experiments were not prosecuted further, because it was assumed that other products, now known and in use,

for gas making, might be employed at less expense for this purpose, than your oil. Nevertheless, this branch of inquiry may be worthy of further attention.

Distillation at a higher temperature.

The results of the distillation at a regulated temperature in glass, led us to believe, that in a metallic vessel capable of enduring a high degree of heat, we might obtain a much larger proportion of valuable products. A copper-still, holding five or six gallons was therefore provided, and furnished with an opening, through which a thermometer could be introduced into the interior of the vessel. Fourteen imperial quarts (or, by weight, 560 ounces) of the crude product were placed in this vessel, and the heat raised rapidly to about 280° C., (=536° Fah.,) somewhat higher than the last temperature reached in the first distillation. At this high temperature the distillation was somewhat rapid, and the product was easily condensed without a worm. The product of the first stage was 130 ounces, (or over 28 per cent.,) of a very light colored thin oil, having a density of .792. This product was also acid, and as before, the acid was easily removed by boiling with fresh water. The temperature was now raised to somewhat above 300° C., (=572° Fah.,) and 123 ounces more distilled, of a more viscid and yellowish oil, having a density of .865. This accounts for over 43 per cent. of the whole quantity taken. The temperature being raised now above the boiling point of mercury, was continued at that until 170 ounces, or over 31 per cent., of a dark brown oil had been distilled, having a strong empyreumatic odor. Upon standing still for some time, a dark blackish sediment was seen to settle from this portion, and

on boiling it with water, the unpleasant odor was in a great degree removed, and the fluid became more light colored and perfectly bright. (It was on a sample of this that the photometric experiments were made.) The next portion, distilled at about 700° Fah., gave but about 17 ounces, and this product was both lighter in color and more fluid than the last. It now became necessary to employ dry hickory wood as a fuel, to obtain flame and sufficient heat to drive over any further portions of the residue remaining in the alembic.

It will be seen that we have already accounted for over 75 per cent. of the whole quantity taken. There was a loss on the whole process of about 10 per cent., made up, in part, of a coaly residue that remained in the alembic, and partly of the unavoidable loss resulting from the necessity of removing the oil twice from the alembic, during the process of distillation, in order to change the arrangements of the thermometer, and provide means of measuring a heat higher than that originally contemplated.

About 15 per cent. of a very thick, dark oil, completed this experiment. This last product, which came off slowly at about 750° Fah., is thicker and darker than the original oil, and when cold is filled with a dense mass of pearly crystals. These are Paraffine, a peculiar product of the destructive distillation of many bodies in the organic kingdom. This substance may be separated and obtained as a white body, resembling fine spermaceti, and from it beautiful candles have been made. The oil in which the crystals float is of a very dark color, and by reflected light is blackish green, like the original crude product. Although it distills at so high a temperature, it boils at a point not very different

from the denser products of the first distillation. The Paraffine, with which this portion of the oil abounds, does not exist ready-formed in the original crude product, but it is a result of the high temperature employed in the process of distillation, by which the elements are newly arranged.

I am not prepared to say, without further investigation, that it would be desirable for the Company to manufacture this product in a pure state, fit for producing candles, (a somewhat elaborate chemical process,) but I may add that, should it be desirable to do so, the quantity of this substance produced may probably be very largely increased, by means which it is now unnecessary to mention.

Paraffine derives its name from the unalterable nature of the substance, under the most powerful chemical agents. It is white, in brilliant scales of a greasy lustre; it melts at about 116°, and boils at over 700° Fah.; it dissolves in boiling alcohol and ether, and burns in the air with a brilliant flame. Associated with Paraffine are portions of a very volatile oil, *Eupione*, which boils at a lower temperature, and by its presence renders the boiling point of the mixture difficult to determine. I consider this point worthy of further examination than I have been able at present to give it, *i. e.*, whether the last third, and possibly the last half, of the Petroleum may not be advantageously so treated as to produce from it the largest amount of Paraffine which it is able to produce.

The result of this graduated distillation, at a high temperature, is that we have obtained over 90 per cent. of the whole crude product in a series of oils, having valuable properties, although not all equally fitted for illumination and lubrication.

A second distillation of a portion of the product which came over in the latter stages of the process, (a portion distilled at about 650° Fah., and having a high color,) gave us a thin oil of density about .750, of light yellow color and faint odor.

It is safe to add that, by the original distillation, about 50 per cent. of the Crude oil is obtained in a state fit for use as an illuminator without further preparation than simple clarification by boiling a short time with fair water.

Distillation by High Steam.

Bearing in mind that by aid of high steam, at an elevated temperature, many distillations in the arts are effected which cannot be so well accomplished by dry heat, I thought to apply this method in case of the present research. Instances of this mode of distillation are in the new process for Stearine candles, and in the preparation of Rosin Oil. I, accordingly, arranged my retort in such a manner that I could admit a jet of high steam into the boiler, and almost at the bottom of the contained Petroleum. I was, however, unable to command a jet of steam above 275° to 290° Fah., and, although this produced abundant distillation, it did not effect a separation of the several products, and the fluid distilled had much the same appearance as the Petroleum itself, thick and turbid. As this trial was made late in the investigation, I have been unable to give it a satisfactory issue, chiefly for want of steam of a proper temperature. But I suggest, for the consideration of the Company, the propriety of availing themselves of the experience already existing on this subject, and particularly among those who are concerned in the distillation of Rosin Oil—a product having many analogies with Petroleum in respect to its manufacture.

Use of the Naphtha for Illumination.

Many fruitless experiments have been made in the course of this investigation which it is needless to recount. I will, therefore, only state those results which are of value.

1.—I have found that the only lamp in which this oil can be successfully burned is the Camphene lamp, or one having a button to form the flame, and an external cone to direct the current of air, as is now usual in all lamps designed to burn either Camphene, Rosin Oil, Sylvic Oil, or any other similar product.

2.—As the distilled products of Petroleum are nearly or quite insoluble in alcohol, burning fluid (*i. e.*, a solution of the oil in alcohol) cannot be manufactured from it.

3.—As a consequence, the oil cannot be burned in a hand lamp, since, with an unprotected wick, it smokes badly. Neither can it be burned in a Carcel's mechanical lamp, because a portion of the oil being more volatile than the rest, rises in vapor on the elevated wick required in that lamp, and so causes it to smoke.

I have found all the products of distillation from the copper still capable of burning well in the Camphene lamp, except the last third or fourth part, (*i. e.*, that portion which came off at 700° F. and rising, and which was thick with the crystals of Paraffine.) Freed from acidity by boiling on water the oils of this distillation burned for 12 hours without injuriously coating the wick, and without smoke. The wick may be elevated considerably above the level required for Camphene without any danger of smoking, and the oil shows no signs of crusting the wick tubes with a coating of Resin, such as happens in the case with Camphene, and occasions so much inconvenience. The light from the rectified Naph-

tha is pure and white without odor. The rate of consumption is less than half that of Camphene, or Rosin Oil. The Imperial pint, of 20 fluid ounces, was the one employed—a gallon contains 160 such ounces. A Camphene lamp, with a wick one inch thick, consumed of rectified Naphtha in one hour, 1 3-4 ounces of fluid. A Carcel's mechanical lamp of 7-8 inch wick, consumed of best Sperm Oil, per hour, 2 ounces. A "Diamond Light" lamp, with "Sylvic Oil," and a wick 1 1-2 inch diameter, consumed, per hour, 4 ounces.

I have submitted the lamp burning Petroleum to the inspection of the most experienced lampists who were accessible to me, and their testimony was, that the lamp burning this fluid gave as much light as any which they had seen, that the oil spent more economically, and the uniformity of the light was greater than in Camphene, burning for 12 hours without a sensible dimunition, and without smoke. I was, however, anxious to test the amount of light given more accurately than could be done by a comparison of opinions. With your approbation I proceeded therefore to have constructed a *photometer*, or apparatus for the measurement of light, upon an improved plan. Messrs. Gunow, scientific artists of this city, undertook to construct this apparatus, and have done so to my entire satisfaction. This apparatus I shall describe elsewhere—its results only are interesting here. By its means I have brought the Petroleum light into rigid comparison, with the most important means of artificial illumination. Let us briefly recapitulate the results of these.

Photometric Experiments.

The *unit* adopted for comparison of intensities of illumination is Judd's Patent Sixes Sperm Candle.

The Sperm Oil used was from Edward Mott Robinson, of New Bedford—the best winter Sperm remaining fluid at 32° Fah. The Colza Oil and Carcel's lamps were furnished by Dardonville, lampist, Broadway, New York.

The Gas used was that of the New Haven Gas Light Co., made from best Newcastle coal, and of fair average quality.

The distance between the standard candle, and the illuminator sought to be determined was constantly 150 inches—the Photometer traversed the graduated bar in such a manner as to read, at any point where equality of illumination was produced, the ratio between the two lights. I quote only single examples of the average results, and with as little details as possible, but I should state that the operations of the Photometer was so satisfactory that we obtained constantly the same figures when operating in the same way, evening after evening, and the sensitiveness of the instrument was such that a difference of one half inch in its position was immediately detected in the comparative illumination of the two equal discs of light in the dark chamber. This is, I believe, a degree of accuracy not before obtained by a Photometer.

Table of illuminating power of various artificial lights compared with Judd's patent candles as a unit.

Source of Light.	Ratio to Candle—1.
Gas burning in Scotch fish-tail tips, 4 feet to the hour,	1 : 5.4
" " " " " 6 " "	1 : 7.55
" " Cornelius " " 6 " "	1 : 6.2
" " English Argand burner 10 " "	1 : 16
Rock Oil, burning in 1 inch wick Camphene Lamp, consuming 1 3-4 ounces of fluid the hour, - - - -	1 : 8.1
Carcel's Mechanical Lamp, burning best Sperm Oil, 2 ounces fluid to the hour, wick 7-8 of an inch, - - -	1 : 7.5
Carcel's " " " " " Colza Oil,	1 : 7.5
Camphene Lamp, (same size as Rock Oil above,) burning best Camphene, 4 ounces fluid per hour, - - -	1 : 1.1
"Diamond Light" by "Sylvic Oil," in 1 1-2 inch wick, 4 ounces per hour, - - - - - - -	1 : 8.1

From this table it will be seen that the Rock Oil Lamp was somewhat superior in illuminating power to Carcel's Lamp of the same size, burning the most costly of all oils. It was also equal to the "Diamond Light" from a lamp of one half greater power, and consequently is superior to it in the same ratio in lamps of equal power. The Camphene lamp appears to be about one fifth superior to it, but, on the other hand, the Rock Oil surpasses the Camphene by more than one half in economy of consumption, (*i. e.*, it does not consume one half so much fluid by measure,) and it burns more constantly. Compared with the Sylvic Oil and the Sperm, the Rock Oil gave on the ground glass diaphgram the whitest disc of illumination, while in turn the Camphene was whiter than the Rock Oil light. By the use of screens of different colored glass, all inequalities of *color* were compensated in the use of the photometer, so that the intensity of light could be more accurately compared. Compared with Gas, the Rock Oil gave more light than any burner used except the costly Argand consuming ten feet of gas per hour. To compare the *cost* of these several fluids with each other we must know the price of the several articles, and this varies very much in different places. Thus, gas in New Haven costs $4 per 1,000 feet, and in New York $3.50 per 1,000. in Philadelphia $2.00 per 1,000, and in Boston about the same amount.

Such Sperm Oil as was used costs $2.50 per gallon, the Colza about $2, the Sylvic Oil 50 cents, and the Camphene 68 cents—no price has been fixed upon for the rectified Rock Oil.

I cannot refrain from expressing my satisfaction at the results of these photometric experiments, since they have given

the Oil of your Company a much higher value as an illuminator than I had dared to hope.

Use of the Rock Oil as a Lubricator for Machinery.

A portion of the rectified oil was sent to Boston to be tested upon a trial apparatus there, but I regret to say that the results have not been communicated to me yet. As this oil does not gum or become acid or rancid by exposure, it possesses in that, as well as in its wonderful resistance to extreme cold, important qualities for a lubricator.

Conclusion.

In conclusion, gentlemen, it appears to me that there is much ground for encouragement in the belief that your Company have in their possession a raw material from which, by simple and not expensive process, they may manufacture very valuable products.

It is worthy of note that my experiments prove that nearly the *whole* of the raw product may be manufactured without waste, and this solely by a well directed process which is in practice, one of the most simple of all chemical processes.

There are suggestions of a practical nature, as to the economy of your manufacture, when you are ready to begin operations, which I shall be happy to make, should the Company require it—meanwhile, I remain, gentlemen,

Your ob't serv't,

B. SILLIMAN, Jr.,

Prof. of Chemistry in Yale College.

New Haven, *April* 16, 1855.

Erratum.—On page 8, tenth line from bottom, for 815, read 800.

= de la Vergne, Yockney and company, New York =
"

SUGGESTIONS

FOR THE USE OF

Cumberland & Brothers' Patent

METALLIC OILS AND GREASE

FOR MACHINERY.

There are two kinds of Metallic Oil—the *Transparent*, and *White* Metallic Oils. The first possessing at least, the fluidity of Sperm Oil, and being entirely free from *gum* or *gluten*, is adapted to the lubrication of all kinds of machinery, and particularly, the lighter or better descriptions, as Cotton and Wool, Locomotives, &c., &c. The other, having greater consistency than the Transparent, is particularly adapted to the lubrication of the heavier or more common descriptions, as Shaftings, the Cylinders and principal Bearings of Steam Engines, &c., &c.

The *Transparent* Metallic Oil, is applied in the same manner as *Sperm* Oil, except that it should, on account of its greater affinity for Metallic substances, be applied in less quantity and less frequently.

The *White* Metallic Oil, being of about the consistency of cream, will not feed through a *wick* freely, nor will it enter so small an aperture as common oil. The outlet of the oiler from which it is applied, should be about an eight ($\frac{1}{8}$) of an inch over. If the bottom of an oil-hole, or the lower part of a journal-box, have sharp, close-fitting edges, the Oil will not pass between the moving and the stationary parts of

1853 ?

the machinery so easily as is desirable; but any person of ordinary ingenuity, understanding this difficulty, would at once devise the proper remedy, such as having the bottom of the oil-hole *countersunk*, the cap of the journal loosened slightly, or the close-fitting edge filed away, so that the Oil may enter in a wedge-like form. The *entrance* of the Oil being thus facilitated, the *motion* of the machinery will *draw* in a proper supply. On the other hand, when the oil-passages are such that the bearings are *certain* to be lubricated, caution is necessary to prevent too copious a supply of this Oil, as any excess in the supply, does more harm than good (aside from the unnecessary *waste*). In such cases, the means of *diminishing* the supply will be obvious; such as stopping part of the oil-hole with a wooden plug, if the supply is constant from an ordinary oil-cup; or, instead of a wooden plug, a number of small wires might be inserted in the oil-hole. When machinery is not adapted to receiving this kind of Oil, the *Transparent* Metallic Oil is recommended. But the greater lasting and cooling properties of the *White* Metallic Oil, will abundantly compensate for the trouble of altering the oil-entrances, when practicable. This kind of Metallic Oil is also an excellent *substitute for Tallow* in Cylinders, when they require lubricating. It ought to be put into the Cylinder in its natural state, without any previous heating. If the packing of the Cylinder should be of *hemp*, and very old and gummy, from the use of bad oil or tallow, a temporary inconvenience may be experienced from the Metallic Oil dissolving the gum, and thus loosening the packing. In such cases, the use of Metallic Oil should be suspended till the Cylinder is re-packed.

Either kind of Metallic Oil has the property of dissolving or loosening any gum on the machinery to which it is applied. The gum thus dissolved or loosened, gives to the Metallic Oil thus applied, a dirty, blackish appearance; and in some situations, the loosened gum collects so as to obstruct the proper feeding of the Oil. But when all the *old* gum is removed, a fine silvery polish or coating will be formed on the rubbing surfaces, and the machinery will remain clean as long as the

Metallic Oil is properly used—except that when *India Rubber* is used in the machinery, and coming in contact with the Oil, the India Rubber *gum* being dissolved by it, will sometimes adhere to the parts which rub against it.

Again, bearings sometimes appear to be perfectly free from gum, but on close examination a *hard gum*, mixed with rust, may be detected on those portions of the bearings where the friction has been slight (as in the case of spindles, which rub only against that side of the bearing towards which the band draws them). When Metallic Oil is applied to the gum and rust which have thus accumulated from the use of other oil, it gradually softens the gummy mixture, and with it forms a paste, which clings both to the moving and stationary parts of the machinery, and has a tendency to retard the motion. Sometimes this paste hardens during the night, while the machinery is at rest, and almost cements the surfaces of metal together, so that it is quite difficult to start the machines in the morning. Of course, this paste must be removed before much advantage can be derived from the use of Metallic Oil. A difficulty *somewhat* similar to that last mentioned, is produced by using *summer* Metallic Oil in cold weather; but the *winter* Metallic Oil will not chill at the ordinary temperature of Spinning and Weaving-rooms.

Bearings lubricated with Metallic Oil, sometimes *seem* to become *dry* very soon, but, in reality, when the bearings present this appearance, there is still a thin, almost imperceptible film of the lubricating substance, adhering to the bearings, protecting them from heating, and diminishing the friction in a remarkable degree. By taking advantage of this property of the Metallic Oil, and abstaining from a fresh application of Oil until it is actually needed, a great saving can be effected in the *quantity* of Oil used.

Particular benefit is to be derived from the use of Metallic Oil on quick-running upright Shafting and Spindles; because (when the supply is not too copious) it adheres to the metal so tenaciously, that it cannot be thrown off by centrifugal force, and its own weight does not make it run *down* too rapidly; it cannot be easily *shaken off* by any jerking motion of the

machinery. On *heavy journals* it is very efficacious, on account of its cooling properties, and because it does not run from a warm bearing, as other oils do.

SPINNING AND WEAVING MACHINERY.

In using Metallic Oil on *Spinning and Weaving Machinery* (which furnish some of the most delicate and severe tests of lubricating oils), particular regard should be paid to the peculiar properties of Metallic Oil. For instance the *flier-nose* of the Throstle Spinning Frame, cannot be oiled properly when *in motion*, there being no certainty that the Oil will reach the bearing as intended, it having a tendency to stay on polished metal, in the exact spot where it is applied. The attraction which exists between it and metal, prevents it from spreading like Sperm and other oils. Sperm Oil will, therefore, sometimes find its way to a bearing, when Metallic Oil will *not*. But the same property which makes it more *difficult* to apply Metallic Oil to the right spot, renders it more *effective* when the oiling is properly accomplished; the Metallic Oil having a tendency to adhere to the bearings, while the friction is spreading it over the *entire* rubbing surfaces; whereas, *Sperm Oil* would, (particularly on warm bearings), unless a great surplus was applied, be likely to *run off* before the rubbing surfaces were completely covered, thus leaving the journals, in a measure, unprotected, and consequently liable to heat. If the Metallic Oil is applied to the flier-nose when at *rest*, *one* oiling per day is sufficient; and the *Spindle* of the same frame, *also* needs but one oiling in a day, except where the Spindle or flier runs in *cast iron*, in which case *two* oilings per day are generally necessary, unless the machinery is of a very light character. Oiling once or twice a *week* is usually sufficient for the lower bearing or *step* of the Spindle. The front steel *roller* requires to be lubricated with Metallic Oil only two or three times a week, except when the roller is heavily weighted, as it generally is in *mule* spinning. In such cases it may be necessary to oil *once* a day.

WASHERS.

When Metallic Oil comes in contact with the *washer* under the Bobbin, if any viscous matter has accumulated on the washer from the use of bad oil, the Metallic Oil will loosen or soften this substance, and the working of the Bobbin will thereby be impeded. But if the washers are *clean*, the Metallic Oil will make the Bobbins move more easily, smoothly and uniformly, than when Sperm Oil is used; and, of course, fewer threads will be broken, than when the motion is irregular. When the washers become saturated with Metallic Oil, it sometimes happens, that the Bobbins revolve too easily, and in other cases not easily enough. Either of these faults is readily remedied, by substituting a washer and button of greater or less size; and when the *draft* is thus once properly regulated, no re-adjustment will be necessary until a new washer is required. In most cases where the difficulty is an *excess* of draft, it is produced by the action of Metallic Oil on the *leather* washer, as this oil has a tendency to open the pores of leather, rendering it quite soft, and thus causing greater friction, or *draft;* whereas, the gum which gradually collects from the use of *Sperm* Oil, *fills* the pores of the leather, which becoming hard by exposure to the air, and polished by the friction, allows the Bobbin to revolve more and more easily, the longer it is used. But when *Metallic* Oil is employed, the draft is uniform during the time that one washer is in use. On *cloth* washers the tendency of Metallic Oil is to make the Bobbins revolve *too easily;* because, since no *gum* results from its use, the fibres of the cloth do not become matted together as when *Sperm* Oil is used; and, consequently, the Bobbins, being partly sustained by the natural stiffness of the fibres (increased perhaps by electricity), are borne up, and their friction or *draft* is thus diminished.

BOBBINS.

Bobbins, which have been used some time, usually have their inner surfaces coated with hard gum. This gum is liable to become softened and loosened by the use of Metallic Oil. If this occurs to such an extent, as to interfere with the motion

of the Bobbins, the collected gum should be removed. Experiments are now being made for the purpose of ascertaining the comparative merits of Metallic and other oils *for soaking Bobbins.* With Metallic Oil the process is much more rapid, and Bobbins soaked in it, will be entirely free from gum, and (it is believed) will run much better than when prepared with any other kind of oil; but the experiments have not yet been continued long enough to determine *all* the facts with certainty, though they have been continued long enough to warrant our *recommending* that Bobbins be soaked ten or twelve minutes in Metallic Oil heated to about 200 degrees, Fahrenheit, then taken out and put into cool Metallic Oil, where they should remain about twenty minutes. Some, however, prefer to soak the Bobbins four or five days in cool Metallic Oil without any extra heat. After the Bobbins have been soaked in either manner above-mentioned, they should lie a few days spread out so as to be all exposed to the air, and then, after being reamed out, they are, first being moderately oiled, ready to be placed on the Spindles. Bobbins prepared as above recommended, contain nearly twice as much oil, as when soaked in any other kind of oil; and as *Metallic* Oil does *not* dry away like other oils, it will, on the Spindle becoming in the least warm, be drawn out from the Bobbin, and act as a lubricator. The result is, that the Bobbins require to be but slightly oiled *twice*, or at most, *three times a week*, instead of from *two* to *six times a day*, as is the case when *soaked* in Sperm, and more particularly in *Linseed*, and *oiled* with *Sperm* Oil. The advantage to be gained here is of very considerable importance, as uniformity of draft for two or three days is obtained, besides saving the time and trouble of frequent oilings. Moreover, the use of Metallic Oil prevents what is called *jumping* of the Bobbin, which is the principal cause of uneveness in the thread, and of its breaking while spinning (for which the *spinner* too frequently blames the *carder*). The imperfections in the thread consequent upon the variation of the draft on the Bobbins, or their jerking motion, also renders the thread more liable to break while passing through the *Sizer* and *Loom*, thus causing great loss of time

in tying knots, which, passing into the cloth, produce in it an unevenness, and necessarily diminished value. Thus the aggregate effect produced by *inequality of draft*, is probably much more important than manufacturers generally consider it.

When Bobbins are soaked in Linseed Oil, and lubricated with Sperm Oil, the effect is an *uneven draft*. When *first* oiled they run hard, from being choked by the quantity of oil which is necessary for continuing the lubrication of them during the time they are being filled with thread; and then they run more and more easily, till the oil is exhausted; and if this occurs before the Bobbins are filled, they then run harder again in consequence of the increased friction of the dry surfaces—the heat produced by this friction does not draw the Linseed Oil out of the Bobbins fast enough, to keep the Spindle properly lubricated, and when drawn out, the Linseed Oil, being of a sticky nature, interferes with the free revolution of the Bobbin. And even if the *lubrication* could be regulated, the Linseed Oil used for soaking Bobbins dries so hard that the surface of the Bobbin which rubs against the washer becomes polished, and the friction is thereby reduced; and the necessary consequence of this gradual reduction of friction is, the preventing of a uniform draft during the time that one Bobbin is in use. By soaking Bobbins in *sperm oil*, the principal objections to Linseed oil, as before mentioned, are avoided; but as the sperm oil *weakens* or *destroys* the *texture* of the wood, thus rendering the *rims* of the Bobbins more liable to become rough, thereby materially *increasing* the *breaking* of the *Threads*, and lessening the *durability* of the Bobbins; a small item, however, in comparison to breaking of the *Threads*.

The *effect* of soaking Bobbins in *Whale Oil*, is similar to that of sperm, except that from its gummy nature, it is still less suitable.

BANDS.

When Metallic Oil is used on Spinning Machinery, and the Spindles are run by cotton or woolen bands, the bands should always be made of *hard-twisted* thread—say six

threads of good quality slightly twisted together, then doubled and slightly twisted again (or a greater or less number of threads in proportion to the work to be performed). This makes what is called a *soft band*, which may be used in a *dry* state, as the threads (being of good quality and well twisted), do not permit the fibres to *whip out*, as the tendency is, when the band is made of *roving*. When *Sperm* Oil is used, the fibres of the roving band are held together, by being saturated with the oil which flies from the revolving spindle; but as *Metallic* Oil never flies off from the Spindle or Bolster, in sufficient quantity to saturate a band, it therefore, would allow a Roving band to whip itself to pieces in a short time. A *thread band*, being kept dry, also has the advantage over Roving, in its property of accommodating itself to changes of the weather, not requiring so frequent shortening or lengthening, and consequently, giving a more uniform tension; so that, besides *lasting* enough longer to make it more *economical*, it also transmits power more regularly, than a Roving band.

WEAVING.

When Metallic Oil is applied to the *picker-rod* of a Loom, if the *picker* has any gummy substance on it (or even between the two thicknesses of hide of which it is composed), this gum is liable to be loosened by the Metallic Oil, and to interfere with the motion of the picker, by collecting on the picker-rod. But when clean pickers are used, a very small quantity of Metallic Oil taken between the thumb and finger, and rubbed on the picker-rod *two* or *three* times a day, is all that is necessary for making the picker traverse easily and regularly. If any superfluity of Oil is applied, it will be pushed toward the end of the rod, and then drop off, or else serve as a nucleus for gathering dust and fibres, (if it is *not* wiped off). Such results *never* occur when Metallic Oil is *properly* used; but with Sperm Oil they are almost unavoidable, it being very difficult to ensure a *sufficient* lubrication from Sperm Oil, without actually applying an *excess*. *Too much Metallic* Oil on the picker-rod is particularly ob-

jectionable, because it is liable to form so thick a coating on the rod, as to obstruct the motion of the picker.

Again ; when Metallic Oil is used on Weaving Machinery, where Pickers are employed, the Pickers should *always* be soaked in oil previous to use. *Metallic* Oil is preferred. The Pickers should lie in the oil five or six days; after which, they should be exposed to the air, about the same length of time.—If the Pickers are *not soaked* previous to use, and *Metallic Oil is* used on the Picker Rod, the Picker will, in consequence of the penetrating nature of the Metallic Oil, absorb the Oil so fast, as to require a fresh application *oftener*, than if Sperm Oil is used.

Another reason why Pickers should be soaked previous to use, is—that in consequence of the unsoaked Picker, continually taking up Oil, that portion of it which rubs on the Rod will become so soft, as to obstruct its free motion. When soaked in Oil (particularly *Metallic* Oil), the rubbing surfaces become polished by the friction, and not only is trouble avoided but two important advantages obtained, cleanliness and economy.

OILERS.

When Metallic Oil is applied from a tin oiler to fine machinery, in order to prevent an excessive supply, the outlet of the oiler, should not be larger than would admit a small pin. An oiler with a steel nose is recommended, because the outlet is not so liable to change of size from breaking or bruising, as when made from tin ; and hence, the aperture remaining uniform, prevents irregularity in applying the oil, which, on spinning machinery, is an important consideration.

WHITE METALLIC OIL.

The *White* Metallic Oil is liable to be partially decomposed under certain circumstances. To prevent this, it is recommended that the Oil should be occasionally shaken or stirred up in the barrel or vessel containing it, and that it should be protected from great changes of temperature. If the ingredients should, by excessive cold or from any other cause, become

so separated that clear Oil appears on the surface of the white compound, no part of the Oil should be used, until a recombination is effected, by thorough admixture. And if this remedy should not prove effectual, the Oil should be returned to the manufacturers, who will cheerfully exchange it, or refund the amount paid for it. The liability to decomposition of the *White* Metallic Oil is here mentioned, not because it is of common occurrence, but because it is *possible ;* and it is desirable that those unacquainted with it, should be instructed how to proceed in every emergency.

White Metallic Oil should not be exposed to a temperature lower than 40 deg. Fahrenheit.

METALLIC GREASE.

There are also two kinds of Metallic *Grease*, viz: *White* Metallic Grease, made of the finest and most carefully selected materials, and *Blue* Metallic Grease, which is a cheaper article, but possessing nearly the same properties. Both kinds of Metallic Grease are intended for lubricating cog gearing, open journals of heavy shafting, and axles of all kinds of vehicles.

The Blue Metallic Grease, however, it being of a coarser quality than the *Hard White*, and of a darker color, is not so suitable for *bright work ;* but being of a tougher nature, and much cheaper, is particularly well adapted for Lubricating Cog-gearing, Waggon Axles, &c., &c. Metallic grease is applied in the same manner as common grease, except that, on account of its greater durability, and inclination to adhere to the surfaces, it should be in *less quantity* and *less frequent*, and should *never* be melted before using; or *if* melted, it should not be made very hot, and should be well mixed before applying it. Metallic Grease is made of various consistences, to suit different purposes, and different climates. In its most usual form, it is about as hard as *dough ;* and is not so sensible to the changes of temperature as other grease; though that which is most suitable for summer, is not well adapted for *winter*, and *vice versa.* But Metallic Grease which has a consistency suitable for Spring or Fall, may be made to answer

a good purpose in *Summer* and *Winter* also, if protected against the extremes of *heat* and *cold*.

REMARKS.

It would be impossible to furnish minute directions for the best manner of oiling *all* kinds of machinery ; and such directions would be more reliable, if they emanated from the *consumers*, rather than from the *manufacturers* of oil. The foregoing details are given merely for the purpose of illustrating some of the properties of Metallic Oil ; and it is believed that any practical and unprejudiced person, who is acquainted with the *nature* of the Metallic Oil, will readily discover the proper method of applying it, in any case to which his attention is directed. Yet it may be expedient to repeat some suggestions for the benefit of those, who are *not well acquainted* with the peculiarities of Metallic Oil, and to impress on them the importance of keeping those peculiarities in mind while testing it. The neglect of such caution might, in some cases, lead to serious inconvenience and loss. In testing Metallic Oil, no advantage will be perceived in using it, until the machinery is thoroughly cleaned. If the oil itself does not remove the old gum rapidly enough, and so thoroughly, that no black greasy substance appears where the oil is applied, then the machinery should be taken to pieces and cleaned with potash, or some other similar substance. The Metallic Oil must not be used too *freely*, nor too *frequently*. The steel-nosed oilers are almost indispensable for properly lubricating *fine* machinery ; for, if an *excess* of Metallic Oil is applied to light machinery, the attraction between the oil, and the metal, is so great, that there is a strong tendency to obstruct, rather than to facilitate motion.

Notwithstanding the general prejudice which exists (*perhaps justly*) against *all new oils*, yet on account of the increasing scarcity and consequent adulteration of *Sperm* Oil, consumers must be convinced of the importance of obtaining a reliable substitute. And it is hoped, that in conducting experiments with Metallic Oil, a *fair and unprejudiced trial* will

be given, and that every little difficulty in the running of the machinery, *really* caused by defective bands, belts, bad quality of cotton or wool, variation in the weather, old gum, &c., &c., will *not* (as has too often been the case), *be attributed* to the use of *Metallic Oil.* It is not pretended that Metallic Oil has the power of *constructing*, or even *repairing machinery;* but it is claimed, that it *excells every other substance* as a *lubricator*, when it has a *fair* chance. Experimenters should consider that the fact of Sperm Oil working *better* than Metallic Oil, *under particular circumstances*, does not establish the *superiority* of Sperm Oil; for, by a slight modification of circumstances, the Metallic Oil may be found to work better than Sperm does, under *any* circumstances. It is for those interested to determine whether, the advantages to be gained by a change, will compensate them for the trouble and expense of changing; and in coming to such determination, they ought not to feel above availing themselves of suggestions from those, who have studied and experimented on the same subject.

INSURANCE.

Many Fire Insurance Companies have required an advanced rate of premium for Insurance, when *chemically* prepared Oils are used, or have restricted the Insured to the use of Sperm Oil. The economy of using Metallic Oil on Spinning and Weaving Machinery, has induced many Manufacturers to apply to the Companies in which they are insured, for a removal of the prohibition, as respects the Metallic Oil.

The following, are some of the companies, who have consented to insure parties using Metallic Oil, at the same rate of premium, as when Sperm Oil is used :

The Howard Ins. Co., by Lewis Phillips, Secretary.
The Hartford Fire Ins. Co., and Connecticut Fire Ins. Co., by E. White, Agent.
The Columbian Fire Ins. Co.; per order of the President, by E. White.
National Fire Ins. Co., by W. C. Kellogg, Secretary.
Commercial Fire Ins. Co., by Chas. J. Martin, Secretary.
Equitable Ins. Co., by R. J. Thorn, President.
Manhattan Fire Ins. Co., Nath. Richards, President.
North Western Ins. Co., Geo. Deming, Agent.
Columbus Insurance Co., E. Fassett, Agent; by J. Sutphen.
Lexington Ins. Co. and Merchants' M. Ins. Co., Buffalo, J. Hoxie, Agent, per J. Sutphen.
T. G. Crary, Agent Augusta Ins. and Banking Co.
Grocers' Fire Ins. Co., by J. Milton Smith, Secretary.
Ætna Ins. Co., by Thomas A. Alexander, Agent.
New York Fire and Marine Insurance Co., by D. Underhill, Secretary.
Protection Insurance Co., J. S. Clark, Agent.
E. C. Finn, Secretary of Long Island Ins. Co.
Franklin Insurance Co., Philadelphia.

In consequence of many losses by Fire, occasioned by the use of *chemically* prepared Oils, the above Companies have, by joint request, caused the Metallic Oil to be analyzed by James R. Chilton, M. D., with a view to determine its *safety* as compared with Sperm Oil. The result is the discovery, that

the Metallic Oil contains *less* of those substances which are liable to ignite by friction, than Sperm Oil.

Experiments made by some of our most prominent Manufacturers, Engineers, and Machinists, to ascertain the *cooling* properties of the Metallic Oils as lubricators for Machinery, have also established their great *superiority* in this respect.

The particulars of some of these tests, and the certificates of approval, which were submitted to the Insurance Companies, are in possession of the Howard Insurance Co., New York, and the Franklin Insurance Co., of Philadelphia, to which, and also, to E. White, Esq., Agent in New York for the Connecticut and Hartford Insurance Co's, *other* Insurance Companies, to whom Manufacturers' may apply for Insurance, are referred.

Copies of the Certificates which are held by "The Howard and Franklin Insurance Co.," and numerous other Testimonials, may be seen at the office of the Manufacturers.

METALLIC OILS AND METALLIC GREASE.

are Manufactured and Sold by

DE LA VERGNE, YOCKNEY & CO.

OFFICE, 36 BROADWAY, NEW YORK.

HINTS TO ENGINEERS AND OTHERS

FOR THE USE OF

"CUMBERLAND BROTHERS' PATENT METALLIC OIL,"

FOR MACHINERY.

There are two kinds of Metallic Oil—one designed for general use, and the other of a peculiar nature, which renders it very durable and cooling wherever it can be properly applied, but requiring certain conditions for its successful application.

The *Transparent* Metallic Oil is to be applied in the same manner as Sperm Oil, except that on account of its greater durability, the application should be less frequent or in less quantity.

The *Fluid White* Metallic Oil being of the consistence of cream, of course will not readily feed through a wick, nor will it enter so small an aperture as common oil. If the bottom of an oil-hole, or the lower part of a journal-box, have sharp, close-fitting edges, the Oil will not pass between the moving and the stationary parts of the machinery so easily as is desirable. Any person of ordinary ingenuity, understanding this difficulty, would at once devise the proper remedy, such as having the bottom of the oil-hole *countersunk*, the cap of the journal loosened slightly, or the close-fitting edge filed away so that the Oil may enter in a wedge-like form. The *entrance* of the Oil being thus facilitated, the *motion* of the machinery will *drag* in a proper supply. On the other hand, when the oil-passages are such that the bearings are *certain* to be lubricated, caution is necessary to prevent too copious a supply of this Oil, as any excess in the supply does more harm than good (aside from the unnecessary *waste*). In such cases, the means of *diminishing* the supply will be obvious; such as stopping part of the oil-hole with a wooden

plug, if the supply is constant from an ordinary oil-cup; or, instead of a wooden plug, a number of small wires might be inserted in the oil-hole. When machinery is not adapted to receiving this kind of Oil, the *Transparent* Metallic Oil is recommended. But the great lasting and cooling properties of the Fluid White Metallic Oil would abundantly compensate for the trouble of altering the oil-entrances, when practicable. This kind of Metallic Oil is also an excellent *substitute for Tallow* in Cylinders, when they require lubricating. It ought to be put into the Cylinder in its natural state, without any previous heating. If the packing of the Cylinder should be of *hemp*, and very old and gummy from the use of bad oil or tallow, a temporary inconvenience may be experienced from the Metallic Oil dissolving the gum, and thus loosening the packing. In such cases the use of Metallic Oil should be suspended till the Cylinder is re-packed.

Either kind of Metallic Oil has the property of dissolving or loosening any gum on the machinery to which it is applied. The gum thus dissolved or loosened, gives to the Metallic Oil thus applied, a dirty, blackish appearance; and in some situations the loosened gum collects so as to obstruct the proper feeding of the Oil. But when all the old gum is removed, a fine silvery polish or coating will be formed on the rubbing surfaces, and the machinery will remain clean as long as the Metallic Oil is properly used—except that when *India Rubber* is used in the machinery, the India Rubber *gum* will sometimes adhere to the parts which rub against it.

Bearings lubricated with Metallic Oil sometimes *seem* to become *dry* very soon. But, in reality, when the bearings present this appearance, there is still a thin, almost imperceptible film of the lubricating substance adhering to the bearings, protecting them from heating, and diminishing the friction in a remarkable degree. By taking advantage of this property of the Metallic Oil, and abstaining from a fresh application of Oil until it is actually needed, a great saving can be effected in the *quantity* of Oil used.

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In using Metallic Oil on *Spinning and Weaving Machinery*, (by which some of the most delicate and severe tests of lubricating oils are furnished) particular regard should be paid to the peculiar properties of Metallic Oil. For instance, the *flier-nose* of the Throstle Spinning Frame cannot be oiled properly when *in motion*, because there is no certainty that the Oil will reach the bearing as intended. The Metallic Oil has a tendency to stay on polished metal in the exact spot where it is applied. The attraction which exists between it and metal, prevents it from spreading like Sperm and other oils. Sperm Oil will therefore sometimes find its way to a bearing when Metallic Oil will not. But the same property which makes it more difficult to apply Metallic Oil to the right spot, renders it more effective when the oiling is properly accomplished. If the Metallic Oil is applied to the flier-nose when at rest, *one* oiling per day is sufficient; and the *Spindle* of the same frame also needs but one oiling in a day, except where the Spindle or flier runs in *cast iron*, in which case two oilings per day are generally necessary, unless the machinery is of a very light character. Oiling once or twice a week is usually sufficient for the lower bearing or *step* of the Spindle. The front steel roller requires to be lubricated with Metallic Oil only two or three times a week.

Again: when Metallic Oil comes in contact with the *washer* under the Bobbin, if any viscous matter has accumulated on the washer from the use of bad oil, the Metallic Oil will loosen or soften this substance, and the working of the Bobbin will thereby be impeded. But if the washers are *clean*, the Metallic Oil will make the Bobbins move more easily, smoothly and uniformly than when Sperm Oil is used; and, of course, fewer threads will be broken than when the

motion is irregular. When the washers become saturated with Metallic Oil, it sometimes happens that the Bobbins revolve too easily, and in other cases not easily enough. Either of these faults is readily remedied by substituting a washer and button of greater or less size; and when the *draft* is thus once properly regulated, no re-adjustment will be necessary until a new washer is required. Bobbins which have been used some time, usually have their inner surfaces coated with hard gum. This gum is liable to become softened and loosened by the use of Metallic Oil. If this occurs to such an extent as to interfere with the motion of the Bobbins, the collected gum should be removed. Experiments are now being made for the purpose of ascertaining the comparative merits of Metallic and other oils *for soaking Bobbins.* With Metallic Oil the process is much more rapid, and it is believed that Bobbins soaked in this Oil will be entirely free from gum, and will run much better than when prepared with any other kind of Oil. But the experiments have not yet been continued long enough to determine the fact with certainty.

When Linseed Oil is used for soaking Bobbins, it dries so hard that the surface of the Bobbin which rubs against the washer becomes polished, and the friction is thereby reduced. The necessary consequence of this reduction of friction is to prevent a uniform *draft* during the time one Bobbin is in use.

Linseed Oil is also objectionable for soaking Bobbins; because, should the Spindle become dry, the consequent heat will draw the Linseed Oil from the Bobbin too slowly to keep the Spindle lubricated; and when drawn, the Linseed Oil being of a sticky nature, interferes with the free revolution of the Bobbin.

Sperm Oil is objectionable for soaking Bobbins, because it has a tendency to make the rims of the Bobbins rough, by lessening the toughness of the wood. The same effects are produced when Bobbins are soaked in Whale Oil, and the gummy nature of Whale Oil renders it still less desirable for the purpose.

Again: when Metallic Oil is applied to the *picker-rod* of a Loom, if the *picker* has any gummy substance on it, (or even between the two thicknesses of hide of which it is composed) this gum is liable to be loosened by the Metallic Oil, and to interfere with the motion of the picker, by collecting

on the picker-rod. But when clean pickers are used, a very small quantity of Metallic Oil taken between the thumb and finger, and rubbed on the picker-rod two or three times a day, is all that is necessary for making the picker traverse easily and regularly. If any superfluity of Oil is applied, it will be pushed toward the end of the rod, and then drop off, or else serve as a nucleus for gathering dust and fibres, (if it is not wiped off.) Such results never occur when Metallic Oil is properly used; but with Sperm Oil they are almost unavoidable, because it is very difficult to ensure a *sufficient* lubrication from Sperm Oil without actually applying an *excess*. Too much *Metallic* Oil on the picker-rod is particularly objectionable, because it is liable to form so thick a coating on the rod as to obstruct the motion of the picker, and because the picker would become so saturated with Oil, on account of the penetrating nature of Metallic Oil, as to admit of its being worn out by the shuttle sooner than it otherwise would be.

Again: bearings sometimes appear to be perfectly free from gum, but on close examination a hard gum, mixed with rust, may be detected on those portions of the bearings where the friction has been slight (as in the case of spindles, which rub only against that side of the bearing towards which the band draws them.) When Metallic Oil is applied to the gum and rust which have thus accumulated from the use of other oil, it gradually softens the gummy mixture, and with it forms a paste, which clings both to the moving and stationary parts of the machinery, and has a tendency to retard the motion. Sometimes this paste hardens during the night, while the machinery is at rest, and almost cements the surfaces of metal together so that it is quite difficult to start the machines in the morning. Of course, this paste must be removed before much advantage can be derived from the use of Metallic Oil. A difficulty *somewhat* similar to that last mentioned, is produced by using *summer* Metallic Oil in cold weather; but the *winter* Metallic Oil will not chill at the ordinary temperature of Spinning and Weaving-rooms.

When Metallic Oil is applied from a tin oiler to fine machinery, in order to prevent an excessive supply, the outlet of

the oiler should not be larger than would admit a small pin. An oiler with a steel nose is recommended, because the outlet is not so liable to change of size from breaking or bruising, as when made from tin.

It would be impossible to furnish minute directions for the best manner of oiling *all* kinds of machinery, and such directions would be more reliable if they emanated from the *consumers* rather than from the manufacturers of oil. The foregoing details are given merely for the purpose of illustrating some of the properties of Metallic Oil, and it is believed that any practical and unprejudiced person who is acquainted with the nature of Metallic Oil, will readily discover the proper method of applying it in any case to which his attention is directed.

Metallic Oil should not be exposed to a temperature lower than 40 deg. Fahrenheit. The *Fluid White* Metallic Oil is liable to be partially decomposed under certain circumstances. To prevent this, it is recommended that the Oil should be occasionally shaken or stirred up in the barrel or vessel containing it, and that it should be protected from great changes of temperature. If the ingredients should, by excessive cold or from any other cause, become so separated that clear Oil appears on the surface of the white compound, no part of the Oil should be used until a recombination is effected by thorough admixture. And if this remedy should not prove effectual, the Oil should be returned to the manufacturers, who will cheerfully exchange it or refund the amount paid for it. The liability to decomposition of the Fluid White Metallic Oil is here mentioned, not because it is of common occurrence, but because it is *possible;* and it is desirable that those unacquainted with it should be instructed how to proceed in every emergency.

There are also two kinds of Metallic *Grease*, viz: *Hard White* Metallic Grease, made of the finest and most carefully selected materials, and *Blue* Metallic Grease, which is a cheaper article, but possessing nearly the same properties. Both kinds of Metallic Grease are intended for lubricating cog gearing, open journals of heavy shafting, and axles of all kinds of vehicles. Metallic Grease is applied in the same manner

as common grease, except that it should *never* be melted before application; or *if melted*, it should not be made very hot, and should be well mixed before applying it. Metallic Grease is made of various consistence to suit different customers and different climates. In its most usual form, it is about as hard as *dough*. The same grease varies in its degree of hardness according to the temperature. That which is most suitable for Summer is not well adapted for *Winter*, and *vice versa*. But Metallic Grease which has a natural consistence suitable for Spring or Fall, may be made to answer a good purpose in Summer and Winter also, if protected against the extremes of heat and cold.

Many Fire Insurance Companies have required an advanced rate of premium for Insurance when *chemically* prepared Oils are used, or have restricted the Insured to the use of Sperm Oil. The economy of using Metallic Oil on Spinning and Weaving Machinery, has induced many Manufacturers to apply to the Companies in which they are insured, for a removal of the prohibition as respects the Metallic Oil.

The following are some of the Companies who have consented to insure parties using Metallic Oil, at the same rate of premium as when Sperm Oil is used:

The Howard Ins. Co., by Lewis Phillips, Secretary.
The Hartford Fire Ins. Co., and Connecticut Fire Ins. Co., by E. White, Agent.
The Columbian Fire Ins. Co.; per order of the President, by E. White.
National Fire Ins. Co., by W. C. Kellogg, Secretary.
Commercial Fire Ins. Co., by Chas. J. Martin, Secretary.
Equitable Ins. Co., by R. J. Thorn, President.
Manhattan Fire Ins. Co., Nath. Richards, President.
North Western Ins. Co., Geo. Deming, Agent.
Columbus Insurance Co., E. Fassett, Agent, by J. Sutphen.
Lexington Ins. Co. and Merchants' M. Ins. Co., Buffalo, J. Hoxie, Agent, per J. Sutphen.
T. G. Crary, Agent Augusta Ins. and Banking Co.
Grocers' Fire Ins. Co., by J. Milton Smith, Secretary.

Ætna Ins. Co., by Thomas A. Alexander, Agent.
New York Fire and Marine Insurance Co., by D. Underhill, Secretary.
Protection Insurance Co., J. S. Clark, Agent.
E. C. Finn, Secretary of Long Island Ins. Co.

In consequence of many losses by Fire occasioned by the use of *chemically* prepared Oils, the above Companies have, by joint request, caused the Metallic Oil to be analyzed by James R. Chilton, M. D., with a view to determine its *safety* as compared with Sperm Oil. The result is the discovery, that the Metallic Oil contains *less* of those substances which are liable to ignite by friction, than Sperm Oil.

Experiments made by our leading Engineers and Mechanists, and in many instances by direction of eminent Manufacturers, to ascertain the cooling properties of the Metallic Oil as a lubricator for Machinery—have also established its great superiority in this respect.

The particulars of these tests and the certificates of approval which were submitted to the Insurance Companies, are in possession of "The Howard Insurance Co.," New York; and other Insurance Companies to whom Manufacturers may apply, are referred to "The Howard Ins. Co." and also to E. White, Esq., Agent in New York for "The Hartford Fire Ins. Co." and "Connecticut Fire Ins. Co."

Copies of the Certificates which are held by "The Howard Insurance Co.," and numerous other Testimonials, may be seen at the office of the Manufacturers.

METALLIC OIL AND METALLIC GREASE

are Manufactured and Sold by

DE LA VERGNE, YOCKNEY & CO.

OFFICE, **36** BROADWAY, NEW YORK.